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(54) Title: METHOD FOR THE PREVENTION OF UNAUTHORIZED DUPLICATION OF INFORMATION-CARRYING SUBSTRATES											
(57) Abstract <p>The present invention relies on one or more intrinsic physical or chemical characteristics of the substrate materials to distinguish unauthorized duplications of information-carrying substrates. In one aspect of the present invention, a method is disclosed for preventing unauthorized duplication of information to be distributed on information-carrying substrates, by requiring such distribution to be through a substrate of a type selected from a designated class of substrates. Unauthorized duplication can be identified by relying on at least one designated intrinsic physical or chemical characteristic that distinctively represents the type of substrate. The designated intrinsic characteristic is detected by an information processing device that is configured to operate to access the information authorized to be distributed using the type of substrate when the designated characteristic has been detected. Accordingly, any duplication of the information on other types of substrates outside said class of substrates would be recognized as not being an authorized duplication by said information processing device. By controlling the availability of the information-carrying substrate material to only authorized information-carrying substrate producers for production of the information-carrying substrate, unauthorized duplication of information-carrying substrates by unauthorized production entities can be prevented. In a further aspect of the present invention, a process is disclosed for the prevention of unauthorized duplication of information-carrying substrates. The process comprises monitoring the "order to delivery" process such that information-carrying substrates are produced without allowing substrate material and/or substrates to be obtained by an unauthorized party.</p>											
<pre> graph TD CH[Content Holder] -- "A. Order # of Substrates" --> AR[Authorized Replicator] AR -- "Report # of Substrates Produced (Data VI) and Shipped (Data VII)" --> AE[Authorizing Entity] AE -- "Report Amount of Polymer Received (Data V)" --> APP[Authorized Polymer Producer] APP -- "Report Amount of Polymer Produced and Shipped (Data III and IV)" --> AE AE -- "B. Determine Amount of Polymer Required to make # of Substrates Ordered and Order Amount of Polymer (Data II)" --> APP APP -- "C. Polymer Produced and Shipped" --> AR AR -- "D. Substrates produced and shipped" --> ADC[Authorized Distribution Center] ADC -- "Report # of Substrates Received (Data VIII)" --> AE </pre>											

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METHOD FOR THE PREVENTION OF UNAUTHORIZED DUPLICATION OF INFORMATION-CARRYING SUBSTRATES

The present invention is directed to a method for preventing the piracy or unauthorized duplication of information-carrying substrates. In particular, the present invention is directed to a process for preventing the piracy of information carried on optical media discs, flash memory cards, integrated circuit cards, smart cards, and other media or information-carrying substrates through unauthorized copying.

Optical media, such as pre-recorded compact discs (CD's) and digital versatile discs (DVD's), traditionally contain information such as computer programs and audio and video recordings. Frequently, these recorded discs are pirated or copied without authorization and sold in a black market without payment of appropriate fees associated with replicating copyright protected assets to the software companies, recording artists or movie studios, as well as optical media format royalties to the original electronic equipment manufacturers, that is the consumer electronics industry. It has been widely reported that software and entertainment content providers and equipment manufacturers are losing billions of dollars annually to piracy or unauthorized duplication.

Optical media discs have traditionally been made from polymers such as polycarbonate, which can easily be obtained in order to make unauthorized duplications. There has been a proliferation of unauthorized replicating plants, which have had easy access to polycarbonate material and stamping equipment. Additionally, some authorized replicators have engaged in unauthorized duplication using, for example, second-shift or after-business-hours production, and off-book accounting methods. The widespread availability of polycarbonate material has permitted large-scale unauthorized duplication by both authorized and unauthorized duplicators.

The unauthorized duplicators have engaged in what is referred to in the industry as "pit copying." This type of piracy is carried out on a mass commercial scale. It entails the use of various techniques to reproduce exact copies of authorized prerecorded media, which are then sold on the black market. One technique involves taking apart legitimate prerecorded media and exposing the pit configuration, in a manner that allows the creation of a mirror-image mold of the pattern of pits and "lands" (the flat surfaces between the pits) that is then imprinted onto the copy. In this manner, the copy includes not only all of the entertainment or software content of the authorized original media but also any anti-piracy coding, identification, authentication or other information that may be contained in the original media. As a result, the anti-

piracy coding or information of the authorized original can then be read or played by users in the same manner as authorized media.

Numerous methods and instruments have been created in the past in order to identify and authenticate articles such as optical media discs. For example, WO 97/24699 discloses a method and apparatus for authentication of articles for protection from forgery and counterfeiting. It involves encoding and encrypting a physical or chemical characteristic in an article and subsequently authenticating the article by redetermining the characteristic, reading and decrypting the encrypted representation, and comparing the decrypted representation with the redetermined characteristic to determine the authenticity of the article. However, although these processes have done well to identify and authenticate articles, they have been less successful in preventing unauthorized duplication.

Prior anti-piracy methods have generally focused on consumer piracy rather than commercial piracy. Consumer piracy includes casual copying, in which duplication is carried out by the consumer. Other forms of copying with which the entertainment industry is concerned includes what is referred to as "RF copying," which involves the generation of a radio frequency signal from the authorized original to a recordable or rewriteable medium, and "bit-to-bit" copying, which involves direct transfer of digital information from the original to the medium onto which it is copied.

The fundamental problem with consumer level anti-piracy technologies lies in their ineffectiveness against unauthorized commercial level duplication. The consumer level anti-piracy circuit, code, flag, or signal is placed on the information-carrying substrate with the information sought to be protected. It does not prevent unauthorized mirror-image copying of all the information on the substrate (both the information sought to be protected and the anti-piracy circuit, code, flag, or signal) at the commercial level, before it reaches the consumer. When the commercial level pirated substrate reaches the consumer, it contains the identical anti-piracy information as the authorized original substrate, "fooling" the reader or player into reading or playing the pirated information-carrying substrate as if it were an authorized copy. Thus, while sophisticated consumer level anti-piracy measures may prevent piracy from occurring at the time of playback or reading of the substrate by the consumer, they do not protect against earlier, commercial level unauthorized duplication.

Existing consumer level anti-piracy methods that exclusively use electronic circuitry, flagging, encoding, or signaling are susceptible to counteracting "defeat technologies" that nullify, disable, suppress or circumvent the anti-piracy technology.

For example, Macrovision's automatic gain control and blanking interval signal alteration designed to prevent unauthorized duplication of video tapes (see U.S. Patent No. 4,631,603) met with the development of inexpensive "black boxes" that could be plugged into a VCR externally by a consumer to suppress the anti-piracy technology. Additionally, although some anti-piracy technologies have been patentable (thus providing an additional, potentially valuable enforcement mechanism), the removal, suppression or circumvention of the anti-piracy circuitry, encoding or signaling is the means by which the piracy is accomplished. As a result, the pirate at the consumer level typically does not practice the patents on the anti-piracy technology in engaging in the act of piracy. Additionally, while consumer-level anti-piracy approaches may include attempting to patent defeat mechanisms, such defeat mechanisms may not be patentable if they are not novel, and it may be very difficult to anticipate and attempt to patent all possible defeat mechanisms that pirates may develop or employ.

The basic limitations of existing anti-piracy methods therefore include (1) their focus on consumer-level rather than commercial level anti-piracy protection; (2) their failure to prevent "pit copying" at the commercial piracy level; (3) their exclusive use of electronic circuitry, flagging, encoding, or signaling that can be either replicated in the unauthorized media or nullified, disabled, suppressed, or circumvented, thereby permitting the playing or reading of the unauthorized media; and (4) their inability to make use of patent protection because the pirates usually do not practice the anti-piracy patents.

Recently, research and development have been directed at optical media discs that offer enhanced data capacity for high density formats, for example containing 30 or more gigabytes of information. These formats will allow more information storage per disc, thus allowing for enhanced features in movies, superior format for digital high definition television, more songs or video content per disc, enhanced software packages, etc. Current research is directed to identifying polymers that can be utilized in such applications. Such applications will also require new players/readers having the ability to read such high density formats for optical discs as well as other media. (See U.S. Patent 5,838,657.) However, the potential for unauthorized duplication or manufacture of new media as well as existing media will remain and will represent significant financial loss to the entertainment industry and other content holders and creators, due to the increasing popularity of such formats.

Therefore, there remains a need to prevent piracy or unauthorized duplication of information-carrying substrates, such as prerecorded or recordable optical media

discs, flash memory cards, integrated circuit cards, smart cards and other media or information-carry substrates, that are not subject to some or all of the basic limitations of the existing art.

5 The present invention relies on one or more intrinsic physical or chemical characteristics (anti-piracy characteristics) of the selected substrate materials to distinguish unauthorized duplications of blank and information-carrying substrates, rather than relying exclusively on electronic circuitry, encoding, flagging, or signaling, as a basis for its anti-piracy method. It addresses commercial level piracy by focusing on the selection and use of substrate materials for fabricating the blank and
10 information-carrying substrates containing the information thereon to be protected.

In one aspect of the present invention, a method is disclosed for preventing unauthorized duplication of information to be distributed on information-carrying substrates by requiring such distribution to be through a substrate of a type selected from a designated class of substrates. Unauthorized duplication can be identified by
15 relying on at least one anti-piracy characteristic designated as an intrinsic physical or chemical characteristic that distinctively represents the type of substrate. The anti-piracy characteristic is detected by an information processing device that is configured to operate so as to access the information (authorized to be distributed using the type of substrate) when the designated anti-piracy characteristic has been
20 detected. Accordingly, any duplication of the information on other types of substrates outside said class of substrates would be recognized as not being an authorized duplication by said information processing device. By controlling the availability of the selected substrate material to only authorized information-carrying substrate producers for production of the information-carrying substrate, unauthorized
25 duplication of information-carrying substrates by unauthorized production entities can be prevented.

In another aspect of the present invention, a machine readable substrate suitable for carrying machine readable information is produced by a process comprising the steps of providing a material selected from a designated class of
30 materials, forming a substrate from the material so that there is at least one anti-piracy characteristic of the substrate, detectable by at least one of an electrical, optical or mechanical mechanism during machine reading of the substrate, and administering the step of forming of the substrate so as to produce data concerning a relationship between an amount of designated material at the beginning of the step of
35 forming and the number of substrates at the end of the step of forming.

In a further aspect of the present invention, an anti-piracy process comprises the steps of providing a substrate made from a material selected from a designated class, so that at least one anti-piracy characteristic of the substrate is detectable by at least one of an electrical, optical or mechanical mechanism during machine reading of the substrate; and administering the step of forming of the substrate so as to produce data concerning a relationship between the amount of material at the beginning of the step of forming and the number of substrates at the end of the step of forming. By further detecting whether or not a respective suspect substrate has the anti-piracy characteristic of a substrate formed in accordance with the steps of forming and administering, one can identify the suspect substrate as an unauthorized substrate if the anti-piracy characteristic has not been detected.

In yet another aspect of the present invention, a process is disclosed for the prevention of unauthorized duplication of information within information-carrying substrates. The process comprises monitoring the "order to delivery" process such that information-carrying substrates are produced without substrates being obtained by an unauthorized party.

In accordance with the present invention, a class of substrates that comprises one or more types of substrates made of different substrate materials is chosen to serve as a medium for carrying information (such as audio, video, text, graphics, and machine readable codes). The suitability of the substrate will depend on the functional capabilities of the substrate (for example, in terms of the quantity of information carried, the media's ability to reflect light, etc.) in relation to its intended use. An example of such a substrate material is a new generation polycyclohexylethylene-type polymer that may be used to produce high density DVD media. The selected information-carrying substrates are also chosen, however, to present an unique intrinsic physical or chemical characteristic (anti-piracy characteristic), such as an operational profile, which can be detected and evaluated by the information processing device on which the information-carrying substrate is to be read or played. The anti-piracy characteristic may be based on performance characteristics such as (for example in the case of an optical disc) the weight and/or density of the disc; the spin rate of the disc; the acceleration and deceleration of the disc; the inertia of the disc; the spectral characteristics such as reflectance of the disc; the optical characteristics such as light transmittance of the disc; the water absorption and dimensional stability of the disc; the data transfer rate of the disc; and the degree of wobble of the disc, or combinations of such characteristics.

The method further involves the use of a information processing device such

as a reader or player that is compatible and interoperable with the selected information-carrying substrate. The reader or player will determine whether the operational profile of the substrate to be read or played fits or does not fit within the operational profile of the selected information-carrying substrate material (although
5 the reader or player may be compatible with, for example, prior generation or existing media in an alternative use and thus be capable of reading or playing prior generation or existing media with or without anti-piracy protection; see, for example, U.S. Patent 5,831,952.) On the basis of this determination, the information processing device will execute instructions of whether to play or read information carried on the substrate,
10 give the user an error message, or otherwise react to the substrate in a specified manner.

In addition to the use of selected polymer materials to form the information-carrying substrate intended to be read or played by a compatible and interoperable information processing device such as a reader or player, the method includes one or
15 more of the following aspects: (1) the selection of materials chosen not only for their unique operational profile and performance characteristics, but also for their novelty as chemical compositions, and thus their patentability; (2) monitoring the ordering, production, and delivery of the information-carrying substrate materials by authorized substrate material producers to be used as authorized media, with the capability to
20 audit the ordering, production and delivery of the materials into and out of authorized information-carrying substrate producers and/or substrate producers, and the producers' use of such materials; and (3) the use of an authorizing entity to grant rights for the manufacture, use and sale of the substrate materials, information processing devices and/or substrate production equipment under specified conditions,
25 and to monitor and/or audit the ordering, production and delivery of the materials, substrates, information processing devices and/or substrate production equipment.

It would also be beneficial to include one or more of the following: (1) to select as the chosen information-carrying substrate material one or more materials that are also difficult to produce or that must be produced in large, visible chemical plants that
30 require significant capital investment; (2) to adopt the substrate materials chosen and the concomitant modifications to player or reader hardware as an industry standard; and (3) to make use of legal remedies, specifically including remedies for infringement of patents on the selected materials, to prevent the unauthorized manufacture, use and sale of the patented materials.

35 The anti-piracy method of the present invention thus provides one or more of the following advantages over existing methods. First, it escapes the susceptibility of

conventional electronic circuitry, flagging, encoding, or signaling to the development of counteracting "defeat technologies" and capitalizes on the unique attributes of the substrate material rather than the essentially arbitrary and replicable characteristics of electronic circuits, codes, flags and signals. Second, it simplifies the anti-piracy approach by using operational performance characteristics of the selected information-carrying substrate material itself, rather than requiring additional circuits, codes, flags or signals to be added to the information during the manufacturing process. Third, it asserts control over the piracy problem by obtaining and enforcing legal rights in the production of the basic material from which the protected information-carrying substrate is manufactured and subjecting pirates who make, use or sell the protected substrate material to liability for patent infringement, rather than relying on copyright protection against individual acts of copyright infringement. Fourth, it monitors the ordering, manufacture, delivery and distribution of the protected and difficult to manufacture substrate material, in contrast to the existing widespread availability of, for example, polycarbonate polymers that are widely available and are not monitored in such manner.

Unlike prior art approaches directed towards preventing unauthorized duplication at the consumer level, the present invention is effective in preventing unauthorized copying at the commercial level. The anti-piracy aspects of the present invention cannot simply be copied at the commercial level onto widely available information-carrying substrates. Under appropriate circumstances, the present invention can create one or more of the following obstacles for potential commercial pirates: impossibility or extreme difficulty of obtaining the protected information-carrying substrate material (compared with, for example in the case of optical discs, the ubiquitously-available polycarbonate material); extreme difficulty of engaging in undetected unauthorized commercial production of the information-carrying substrate material, because such production would require significant know-how, and would have to occur in large, highly visible, and heavily regulated chemical plants that require tremendous capital investment; monitoring and auditing of authorized production and distribution of the protected information-carrying substrate material; control of the information carrying substrate material, rather than attempting to control easily concealable and transportable replicating equipment; and subjecting unauthorized production to exclusion and enforcement based on the patent laws, as well as less-effective copyright law protection.

The present invention also is effective in preventing unauthorized commercial level "bit-to-bit" copying. By controlling the availability of blank substrates and

substrate material, the present invention prevents the commercial "bit-to-bit" pirate from gaining access to blank substrates onto which to transfer or copy digital information.

5 In addition to anti-piracy protection at the commercial level, the present invention provides protection against significant categories of consumer level unauthorized duplication. The consumer will not be able to obtain blank information-carrying substrate media on which to copy authorized media, or at least will be required to compensate content rights holders appropriately. While copying of high density DVD discs to prior generation recordable media may be possible (assuming
10 the consumer level pirate is able to circumvent or disable existing media anti piracy protections) the pirate will lose special content features that can only be delivered in the new media as well as quality of delivery improvements in the new media. Thus, the invention also supplements existing anti-piracy methods at the consumer level.

The method of the present invention applies to a wide variety of information-carrying substrates. It is useful for any information-carrying substrate that is
15 functionally appropriate for its intended purpose and that has a unique operational profile that can be recognized by a compatible and interoperable information-playing or information-reading device in determining whether to read or play the information. Thus, the invention may be applied to information-carrying media other than optical
20 discs, such as integrated circuit cards, which can be very valuable and the unauthorized use of which can pose security risks, as well as flash memory cards or chips, smart cards that may be used in a variety of applications, credit or debit cards, and other information-carrying substrates..

Brief Description of the Drawing

25 Figure 1 is one depiction of the process flow in the prevention of unauthorized duplication of information-carrying substrates. The drawing also represents the system architecture which can be used in developing data flow diagrams for computer implementation of information management in the prevention of unauthorized duplication of information-carrying substrates.

30 The present invention relies on one or more intrinsic physical or chemical characteristics of the substrate materials to distinguish unauthorized duplications of blank and information-carrying substrates, rather than relying exclusively on electronic circuitry, encoding, flagging, or signaling, as a basis for its anti-piracy method. An information-carrying substrate is any object which contains prerecorded or stored
35 information, while a blank substrate is any object that is capable of storing or containing information, such as digital information. Types of substrates include

identification cards, flash memory materials, fiber optics, computer chips and optical media discs, including CD's, DVD's, and HD-DVD's and substrates configured with the following sequences for playback including: audio, video, text, graphics, and/or machine readable codes. The present invention addresses commercial level piracy by focusing on the selection and use of substrate materials for fabricating the information-carrying substrate containing the information thereon to be protected.

In one aspect of the present invention, a method is disclosed for preventing unauthorized duplication of information to be distributed on information-carrying substrates by requiring such distribution to be through a substrate selected from a designated class of substrates having anti-piracy characteristics. More specifically, substrates having the anti-piracy characteristic described herein constitute a class of substrates. This class of substrates is designated to be the authorized substrates for distribution of specific information. For example, optical media discs having an anti-piracy characteristic is considered one example of a type of substrate within the class of substrates. Additionally, types of substrates may be made of different materials. For example the optical media discs, having the anti-piracy characteristic, may comprise discs made from polycyclohexylethylene polymers and discs made from cyclic olefin copolymers. Unauthorized duplication can be identified by relying on at least one designated anti-piracy characteristic that distinctively represents the type of substrate. The designated anti-piracy characteristic is detected by an information processing device. The device is configured to operate so as to access the information, which has been authorized to be distributed using the type of substrate, when the designated anti-piracy characteristic has been detected. Accordingly, any duplication of the information on other types of substrates outside said class of substrates would be recognized as not being an authorized duplication by said information processing device. By controlling the availability of the selected substrate material to only authorized information-carrying substrate producers for production of the information-carrying substrate, unauthorized duplication of information-carrying substrates by unauthorized production entities can be prevented. The control may be by way of, for example, monitoring (for example, by an authorizing entity) the supply and flow of substrate materials designated for the anti-piracy enabled substrates, and correlation of, for example, the amount of substrate materials produced, the number of substrates produced by the information-carrying substrate producer or blank substrates produced by blank substrate producers, and the number of information-carrying substrates authorized by the content rights holder. Any discrepancy in the

flow process would show that there is potential unauthorized duplication. The control may also be accomplished by one or more of the following:

- protecting a proprietary right for a composition of substrate material for production of the substrate;
- 5 - protecting a proprietary right for a process for manufacturing the substrate material;
- patenting a composition for the substrate material; and
- patenting a process for manufacturing the substrate material.

The anti-piracy characteristic of the substrates is selected so as to be
10 detectable by compatible and interoperable information processing devices. For example, an anti-piracy characteristic of an optical disc made of special polymers (examples disclosed below) is detectable by an optical media disc reader/player having a piracy detection means. The reader/player includes a mode in which it will not read or play any information that is supposed to have been recorded on
15 substrates having anti-piracy characteristics, but which in fact does not fall within the class of anti-piracy substrates. In the example of optical disc, any disc that carries the same information, but does not fall within such class of substrates (that is, without the anti-piracy characteristics) would be detected by the reader/player as an unauthorized duplication of the information. The reader/player is configured to reject operation of
20 such an unauthorized disc. However, the reader/player may be configured to be operable with discs outside of the class of anti-piracy substrates as long as they do not carry content that has been designated to be distributed using such class of substrates. Accordingly, readers/players may be designed to be backward-compatible with prior art substrates.

25 In accordance with an enhancement of the present invention, an indicator (for example, a flag) is included in the information carried on the substrate, the authorized distribution of which is through the use of the class of anti-piracy substrates. The indicator is also detected by compatible and interoperable information processing devices that are enabled to detect such an indicator. Upon detection of the indicator,
30 the information processing device determines that the information is associated with the class of anti-piracy substrates, and looks for an anti-piracy characteristic of the substrate to confirm that the information is indeed duplicated on a substrate belonging to such class, and hence an authorized duplication. Further, the indicator may specifically identify the particular type of substrate to the information processing
35 device. This allows the information processing device to apply the relevant criteria (including, for example, parameters relating to operational profile or instruction sets)

to detect the anti-piracy characteristics. If the anti-piracy characteristic is not detected even though the indicator represents that there should have been one, the information processing device rejects operation of the substrate. The assumption made in this embodiment is that the unauthorized duplication of the information would necessarily
5 duplicate the indicator as well, which serves to flag the information processing device to confirm the authenticity of the substrate. The information processing device can make use of this feature to distinguish the mode of operations for information recorded on prior art substrates and the present inventive substrates.

In the event the same information is authorized to be distributed on different
10 types of substrates selected from the class of substrates having anti-piracy characteristics, a different indicator is applied to the different types of substrates. This allows an information processing device configured to detect different anti-piracy characteristics and indicators to detect the anti-piracy characteristics of each type of substrates based on their corresponding detection criteria as represented by the
15 different indicators. Thus, a single information processing device can be operable with many types of substrates.

To further enhance the anti-piracy effect, different kinds of information (for example, different movies) may be contained within different types of substrates (or at least a manageable variety of substrates) so that each kind of information is
20 associated with a distinct characteristic and a different corresponding indicator. In the event one tries to duplicate the information by "pit copying" from one type of substrate to another type within the class of anti-piracy substrates, the indicator would be duplicated, but would not correspond to the substrate to which the information was copied.

25 One step in the method of preventing unauthorized duplication of information to be distributed on information-carrying substrates is a step of controlling the availability of a selected substrate material to only 1) authorized information-carrying substrate producers for production of the information-carrying substrates and/or 2) authorized blank substrate producers for production of the blank substrates, thereby
30 preventing unauthorized duplication of blank and/or information-carrying substrates by unauthorized substrate producers. This step typically comprises monitoring at least one of the following in connection with production and delivery of blank and/or information-carrying substrates:

(i) the amount of the substrate material produced by the authorized
35 substrate material producers,

- (ii) the amount of substrate material transferred to authorized information-carrying substrate producers,
- (iii) the number of the information-carrying substrates produced by the authorized information-carrying substrate producers from substrate material,
- 5 (iv) the amount of the substrate material transferred to authorized blank substrate producers,
- (v) the number of the blank substrates produced by the authorized blank substrate producers,
- (vi) the number of blank substrates transferred to the authorized
- 10 information-carrying substrate producers,
- (vii) the number of information-carrying substrates produced by the authorized information-carrying substrate producers from blank substrates,
- (viii) the number of information-carrying substrates transferred to the authorized distributors for distribution,
- 15 (ix) the number of information-carrying substrates that are authorized by content rights owners to be produced by the authorized information-carrying substrate producers, and
- (x) the number of blank substrates ordered by an authorized distributor to be produced by the authorized blank substrate producers.

20 The process can further comprise designating an authorizing entity that monitors and correlates the number of substrates produced in (ix) or (x) to at least one of the number and amount quantities in (i) to (viii), so as to determine whether substrate material and/or substrates have been made available to unauthorized substrate producers. In particular, the authorizing entity can correlate the number of

25 information-carrying substrates produced in (ix) to the number and volume quantities in (i), (ii), (iii), (vii) and (viii) and the number of blank substrates in (x) to the number and volume quantities in (iv) to (vi).

A specific embodiment of such a process is detailed in Fig. 1.

Fig. 1 is one embodiment of the process flow in the prevention of unauthorized

30 duplication of information-carrying substrates. The drawing also represents the system architecture which can be used in developing data flow diagrams for computer implementation of information management in the prevention of unauthorized duplication of information-carrying substrates. The example used in this embodiment relates to optical discs made of polymer. Other types of substrates in other formats

35 are within the scope and spirit of the present invention.

The functions of the blocks in Fig. 1 are as follows:

- Authorizing entity 1

One or more companies or business organizations which controls and monitors the manufacturing and delivery of information carrying substrates.

- Content rights holder or content holder 2

5 A party who owns or controls valuable information and data, which may include copyrighted contents of music, video and computer software in digital form.

- Authorized replicator 3

10 An authorized information-carrying substrate producer, which may include, for example, a producer of optical media devices/discs which may contain content holders' copyrighted or proprietary information who have been authorized by the content holders and/or authorizing entity to produce such discs.

- Authorized polymer producer 4

15 An example of an authorized substrate material producer, which may include, for example, a polymer manufacturer authorized by the authorizing entity to produce the specified polymer for optical media disc applications or other specified application.

- Authorized distribution center 5

An authorized distributor, which may include, for example, a retail store or business authorized by the content holders and/or authorized entity to sell recorded or recordable discs.

20 The steps depicted in Fig. 1 are as follows:

Step A entails the initial ordering of information carrying substrates. The information related to the number of information-carrying substrates ordered is reported to the authorizing entity and is incorporated as the first set of data values (Data I) in an electronic format managed by the authorizing entity.

25 Step B comprises the determination of the amount of polymer required to produce the ordered number of information-carrying substrates by the authorizing entity, and ordering the appropriate amount of polymer from an authorized polymer producer. The information related to the amount of polymer ordered is incorporated as the second set of data values (Data II) in an electronic format managed by the
30 authorizing entity.

Step C comprises producing the polymer and shipping the polymer to an authorized replicator. The information related to the amount of polymer produced and shipped by the authorized polymer producer is reported to the authorizing entity and is incorporated as the third and fourth set of data values (Data III and Data IV) in an
35 electronic format managed by the authorizing entity. The information related to the amount of polymer received by the authorized replicator is reported to the authorizing

entity and is incorporated as the fifth set of data values (Data V) in an electronic format managed by the authorizing entity.

Step D comprises the production and shipment of the information-carrying substrates. The information related to the number of information-carrying substrates produced and the number of substrates shipped by the authorized replicator is reported to the authorizing entity and is incorporated as the sixth and seventh sets of data values (Data VI and Data VII) in an electronic format managed by the authorizing entity. The information related to the number of information-carrying substrates received by the authorized distribution center is reported to the authorizing entity and incorporated as the eighth set of data values (Data VIII) in an electronic format managed by the authorizing entity.

More specifically, one embodiment of the process of the present invention comprises monitoring the "order to delivery" steps of a supply chain for such substrates such that information related to each step is electronically recorded and verified. The "order to delivery" steps of a supply chain comprise any steps relating to the ordering of information-carrying substrates, the ordering of a specified polymer to produce said substrates, the production and delivery or transferring (shipping by one party and receiving by another) of polymer, the production of said substrates, and the delivery or transferring (shipping by one party and receiving by another) of said substrates. The information relating to these steps include any information relating to the number of substrates ordered, the identity of the party placing the order, the substrate producer or authorized replicator specified by the party placing the order, the authorized polymer producer specified by the substrate producer, the amount of polymer needed and ordered for the production of the ordered substrates, the amount of polymer produced by the authorized polymer producer, the amount of polymer received by the substrate producer or authorized replicator, the amount of polymer shipped by the authorized polymer producer, the number of substrates produced from the polymer and shipped by the substrate producer or authorized replicator, and the number of substrates received by the final distributor. Such information is electronically recorded and verified as part of an anti-piracy process.

Accordingly, one aspect of the present invention is a process for preventing the unauthorized duplication of information-carrying substrates comprising monitoring the "order to delivery" steps of a supply chain such that information relating to each step is electronically recorded and verified utilizing a computer or a computer network, wherein the steps comprise:

--ordering of information-carrying substrates,

- ordering of a specified polymer to produce said substrates,
- producing and delivering (shipping and receiving) said polymer,
- producing said substrates, and
- delivering (shipping and receiving) said substrates;

5 and the information relating to the steps comprises:

- the number or amount of said substrates ordered,
- the amount of specified polymer ordered to produce said substrates,
- the amount of said polymer produced,
- the amount of said polymer shipped,
- 10 --the amount of said polymer received,
- the number of said substrates produced, and
- the number of said substrates shipped, and
- the number of said substrates received.

15 The electronic recording and verification of the information is managed by an authorizing entity which may comprise one or more companies or business organizations. The authorizing entity controls and monitors the manufacture and delivery of information-carrying substrates.

In one embodiment, the present invention is a process for preventing the unauthorized duplication of information-carrying substrates comprising the steps of :

20 I) establishing an authorizing entity to monitor the "order to delivery" steps of a supply chain in the production and delivery of information-carrying substrates;

II) establishing or defining one or more anti-piracy characteristics imparted on the information-carrying substrate, which enables the information contained within the information-carrying substrate to be accessed only through the use of a information
25 processing device having a piracy detection means; and

III) monitoring the "order to delivery" steps of a supply chain in the production and delivery of the information-carrying substrates.

More specifically, III can comprise:

- a) receiving an order notification for pre-recorded or blank recordable optical
30 media discs, wherein the notification identifies an authorized optical media disc replicator who will produce the discs,
- b) determining the amount of specified polymer needed to produce the number of discs ordered,
- c) ordering the amount of said polymer needed from a authorized polymer
35 producer(s), wherein the authorized polymer producer(s) has been specified by the authorized replicator,

- d) notifying the authorized replicator of the amount of polymer ordered,
- e) receiving notification from the authorized polymer producer(s) of the amount of polymer produced and shipped to the authorized replicator,
- f) receiving notification from the authorized replicator of the amount of polymer
5 received from the authorized polymer producer(s),
- g) comparing the amounts reported by the authorized replicator and the authorized polymer producer(s) to identify any significant discrepancies in the amount of polymer ordered versus the amount of polymer produced, the amount of polymer shipped and/or the amount of polymer received,
- 10 h) receiving notification from the authorized replicator of the number of discs produced and shipped or delivered to an authorized distribution center, and
- i) receiving notification from the authorized distribution center of the number of discs delivered or received,
- j) comparing the number of discs reported to be produced by the authorized
15 replicator, the number of discs reported as received by the authorized distribution center, and the number of discs originally ordered, and identifying any discrepancies, and,
- k) comparing the amount of polymer produced by the authorized polymer producer, the amount of polymer shipped by the authorized polymer producer, and
20 the amount of polymer received by the authorized replicator, and identifying any significant discrepancies.

A significant discrepancy would include a difference in the amount of polymer produced and the total of the amount of polymer delivered and the amount of polymer scrapped or offgraded. Discrepancies can be investigated and reported to the
25 appropriate governmental or enforcement agencies, as well as to the parties which may be negatively affected by the unauthorized duplication of such discs.

For the purpose of the present invention, the term "transferred", "shipping" or "shipped" refers to items or materials being transported from one location to another in any manner.

30 One step in the above process can comprise the authorizing entity receiving an optical media disc order notification from both the authorized replicator and the party placing the disc order. This order typically originates from either a content rights holder in the case of pre-recorded discs or a distribution center in the case of recordable discs. The disc order is generally placed with an authorized replicator,
35 while an order notification is sent to the authorizing entity. In this way, the choice of authorized replicator can be left to the original customer placing the order. The

authorized replicator is typically authorized or licensed to produce optical media discs using specified optical media formats and polymer, and to replicate content material for prerecorded formats. The authorized replicator also participates in the monitoring process wherein the authorized replicator reports to the authorizing entity the number
5 of polymer pounds received and the number of discs shipped. The authorized replicator is typically obligated through a legal agreement with the authorizing entity to produce only the number of discs ordered from the amount of polymer received, such that no polymer or discs can be obtained by an unauthorized party.

From the order notification, the amount of specified polymer needed to produce
10 the number of discs ordered is determined, and the appropriate amount of polymer is ordered from the authorized polymer producer(s), wherein the authorized polymer producer has been specified by the authorized replicator. The amount of polymer needed can be determined utilizing a computer program which will convert the number of discs ordered to the amount of polymer needed. The authorizing entity
15 also notifies the authorized replicator of the amount ordered. The authorized polymer producer(s) is typically authorized or licensed to produce the appropriate polymer and deliver to the authorized replicator. The authorized polymer producer will also participate in the monitoring process, wherein the authorized polymer producer reports to both the authorizing entity and the authorized replicator, the number of
20 polymer pounds produced, and the number of polymer pounds shipped to the authorized replicator. The authorized polymer producer is typically obligated through a legal agreement with the authorizing entity to produce and ship only the amount of polymer ordered through the authorizing entity, such that no polymer can be obtained by an unauthorized party.

Once the authorizing entity receives notification from the authorized polymer
25 producer of the amount of polymer produced and shipped, and the amount of polymer received from the authorized replicator, the numbers are compared for any significant discrepancies. This can be accomplished by utilizing a computer implemented program wherein the information is analyzed and compared to identify discrepancies.
30 If significant discrepancies are found, the matter is investigated to determine if any polymer was obtained by an unauthorized party or diverted by a party involved in the process of this invention.

The authorized replicator then produces the discs ordered and ships or delivers
35 them to a distribution center "authorized" by the requester, while also notifying the authorizing entity of the number of discs sent to the authorized distribution center. Once the authorizing entity receives the notification from the authorized replicator of

the number of discs sent to the authorized distribution center(s), and notification from the distribution center(s) of the number of discs received, these numbers are compared to the original number ordered. This can also be achieved using a computer implemented program as mentioned previously. If a discrepancy is found, the matter is investigated to determine if any discs were obtained by an unauthorized party or diverted by a party involved in the process of this invention. The authorized distribution center is typically obligated through a legal agreement with the authorizing entity to receive and stock only the discs received by an authorized replicator and ordered through the authorizing entity, such that no discs can be obtained by an unauthorized party.

An electronic data interface can be utilized to organize the information regarding discs and polymer ordered vs. received, in order to automate the process and have discrepancies identified. Typically, information such as the number or amount of said substrates ordered, the amount of specified polymer ordered to produce said substrates, the amount of polymer produced, the amount of polymer shipped, the amount of polymer received, the number of said substrates produced, and the number of said substrates shipped, the number of said substrates received, is stored in a database of computer-implemented and executed logic as data values. In conjunction with a computer, computer-implemented and computer executed logic is used in recording and managing information respective to the anti-piracy method. This can be accomplished using a computer or computer network and a computer program code directed to the function of monitoring the "order to delivery" steps of a supply chain. The computer typically comprises a central processing unit (CPU), at least one physical memory connected to the CPU, an input keyboard connected to the CPU, an output display, such as a printer, printing terminal, and/or monitor, connected to the CPU, a computer clock pulse generator within the CPU for providing periodic signals which assist in latching and interconnecting internal circuits in the CPU and in synchronizing operations of the CPU in real-time, and a connection to electrical power for energizing all of the electrically activated components of the computer. The CPU further comprises control circuits, a bus, and specific computer circuits for either temporarily holding data (for example, a register or an accumulator), for executing fundamental data processing operations (for example, an addition circuit and/or a Boolean logical operation circuit), or for executing types of instructions (for example, an arithmetic logical unit or ALU combining arithmetic and logical operations into an essentially unified sub-circuit). The specific computer circuits are connected in communication to the control bus and, in some cases, to each other through latching

circuits which can individually be in either a conduction (communicating) or non-conducting (non-communicating) configuration. The computer also has computer program code in the form of a commercially available operating system which functions as a computer program code platform for enabling the execution of the special purpose computer program code directed to the particular function of monitoring the "order to delivery" steps of a supply chain. Also, a set of networked or otherwise linked computers can collectively function to execute the computer program code.

The computer program code may be in the form of, for example, inter-linked modules, routines and subroutines, program objects, and/or installed interactive processes. In some computer designs, enabled by modern application specific integrated circuitry (ASIC) technology, computer program code may be at least partially expressed in hardwired circuitry which executes simplified logical scenarios without need for computers capable of executing sequential instructions in conjunction with a clock pulse. It is useful to reference the computer program code collectively in execution with the computer as 'logic', with the logic being further subdivided to include logical engines, logical data schema, and logical linkages. Logical engines refer to useful virtual functional elements within the logic which read data, write data, calculate data, and perform decision operations related to data. Logical data schema refer to useful virtual functional elements within the logic which store and hold data in a systematic and methodical manner for convenient access in electronic or other form. A logical data schema is, therefore, a collection, assembly, and compilation of data in a methodical way for use in the computer. The data values used in the process of the present invention includes for example, the number of substrates ordered, the amount of polymer needed to produce the substrates, the amount of polymer produced, the amount of polymer shipped, the amount of polymer received, the number of substrates produced, the number of substrates shipped, and the number of substrates received. Logical linkages function to define useful virtual functional data pipelines between logical engines and logical data schema. A logical linkage facilitates data communication (in a datalogical context) between other logical entities. A link or connection in computer processing, therefore, usually has both a physical attachment and a logical linkage dimension which allows information to be meaningfully exchanged across the physical attachment. A logical engine executes a useful process on data, a logical data schema holds data in a usefully organized way in a structural arrangement, and a logical linkage provides a communication path

between different logical engines and/or logical data schema for the transfer of data between any two of these logical entities.

The terms 'electronically analyzing' refers to the comparison of the relevant data values within the groups of Data I, II, III, IV, V, VI, VII, and VIII as referred to in Figure 1, such that discrepancies can be identified. For example, the data values of Data I are compared to the Data values of Data VII, to determine if the number of discs ordered is substantially equal to the number of discs produced and shipped by the authorized replicator. If a substantial difference is identified, an error signal or other notification tool would be used to notify the authorizing entity that such a discrepancy exists. Likewise, the data values of Data II, Data III, Data IV and Data V are compared to determine if the amount of polymer ordered, the amount of polymer produced, the amount of polymer shipped, and the amount of polymer received are substantially the same. In addition, the data values of Data VI, Data VII and Data VIII are also compared to determine if the number of substrates produced, substrates shipped and substrates received are substantially equal. Once a discrepancy is identified, it can be investigated and reported, if need be, to the content holders, appropriate authorities, etc., in order to prevent any further unauthorized activity.

In another aspect, the present invention is a process for managing information in preventing the unauthorized duplication of information-carrying substrates and electronically monitoring the "order to delivery" steps of a supply chain utilizing a computer or computer network, wherein the steps comprise:

- ordering of information-carrying substrates,
 - ordering of polymer to produced the said substrates,
 - producing and delivering (shipping and receiving) said polymer,
 - producing said substrates, and
 - delivering (shipping and receiving) said substrates;
- comprising:
- storing at least one data value in the memory of a computer which corresponds to the number of said substrates ordered,
 - storing at least one data value in the memory of a computer which corresponds to the amount of specified polymer ordered to produce said substrates,
 - storing at least one data value in the memory of a computer which corresponds to the amount of said polymer produced,
 - storing at least one data value in the memory of a computer which corresponds to the amount of said polymer shipped,
 - storing at least one data value in the memory of a computer which

corresponds to the amount of said polymer received,

-- storing at least one data value in the memory of a computer which corresponds to the number of said substrates produced, and

5 -- storing at least one data value in the memory of a computer which corresponds to the number of said substrates shipped,

-- storing at least one data value in the memory of a computer which corresponds to the number of said substrates received, and

10 --electronically analyzing the data values related to the number of substrates ordered, the number of substrates produced, the numbers of substrates shipped and the number of substrates received; and the amount of polymer ordered, the amount of polymer produced, the amount of polymer shipped, and the amount of polymer received to identify any discrepancies.

15 In another embodiment, the present invention is a general purpose computer or computer network useful for managing information in preventing the unauthorized duplication of information-carrying substrates and electronically monitoring the "order to delivery" steps of a supply chain, wherein the steps comprise:

--ordering of information-carrying substrates,

--ordering of polymer to produced the said substrates,

--producing and delivering (shipping and receiving) said polymer,

20 --producing said substrates, and

--delivering (shipping and receiving) said substrates;

wherein the computer or computer network comprises:

--a means for storing at least one data value in the memory of a computer which corresponds to the number of said substrates ordered,

25 --a means for storing at least one data value in the memory of a computer which corresponds to the amount of specified polymer ordered to produce said substrates,

-- a means for storing at least one data value in the memory of a computer which corresponds to the amount of said polymer produced,

30 -- a means for storing at least one data value in the memory of a computer which corresponds to the amount of said polymer shipped,

-- a means for storing at least one data value in the memory of a computer which corresponds to the amount of said polymer received,

35 -- a means for storing at least one data value in the memory of a computer which corresponds to the number of said substrates produced, and

-- a means for storing at least one data value in the memory of a computer

which corresponds to the number of said substrates shipped,

-- a means for storing at least one data value in the memory of a computer which corresponds to the number of said substrates received, and

5 --a means for electronically analyzing the data values related to the number of substrates ordered, the number of substrates produced, the numbers of substrates shipped and the number of substrates received; and the amount of polymer ordered, the amount of polymer produced, the amount of polymer shipped, and the amount of polymer received to identify any discrepancies.

10 In a preferred embodiment, the process of the present invention is enhanced by the use of a licensing strategy, wherein the specified polymer used in producing the information-carrying substrates is protected by intellectual property owned by a polymer technology holder in the form of know-how and/or patent(s). Therefore, the right to make, use or sell the polymer must be obtained by the parties participating in the process of the present invention.

15 One embodiment of such a licensing strategy or process comprises:

- 20 - a polymer technology holder granting a royalty-bearing, worldwide, exclusive license, with rights to sublicense, to the authorizing entity, under all information, know-how and patents (licensed technology) owned by the polymer technology holder, for the use and sale of the polymer (licensed polymer), wherein the polymer technology holder does not license any third party for the manufacture of the licensed polymer, without the third party signing an appropriate agreement with the authorizing entity in support of the process of the present invention, obligating them to terms and conditions comparable to those agreed upon by the authorizing entity and the polymer technology holder;
- 25 - the authorizing entity granting a royalty-free, worldwide, non-exclusive license, without right to sublicense, back to the polymer technology holder under the licensed technology, for sale of the licensed polymer to any third party (for example authorized replicator) who is licensed by the authorizing entity under the licensed technology, for the use of the licensed polymer, subject to certain reasonable security measures satisfactory to the authorizing entity in connection with the distribution of the licensed polymer;
- 30 - the authorizing entity sublicensing, without right to further sublicense, third parties under the licensed technology for the sale of the licensed polymer, provided that the third party agrees to terms and conditions
- 35

comparable to those agreed upon by the authorizing entity and the polymer technology holder;

- the authorizing entity granting, directly or indirectly, all other necessary sublicenses relating to the use and sale of the licensed polymer to appropriate third parties, as needed, for the successful implementation of the process of the present invention, setting forth relevant requirements for reporting measures concerning the distribution of the licensed polymer;

- the authorizing entity also granting sublicenses to customers of the polymer technology holder and of their polymer licensees of licensed technology, for the use of polymer in applications other than in the production of information-carrying substrates, wherein such sublicensees, in support of the process of the present invention, would obligate themselves not to use, transfer or sell the licensed polymer in information-carrying substrate applications, and further agree to report to the authorizing entity, shipment receipts and use data (including amounts of scrap generated) for licensed polymer, as well as undertake certain reasonable security measures satisfactory to the authorizing entity to minimize the risk of unauthorized use of licensed polymer in information-carrying substrate applications;

- the licensed parties being obligated to under such license agreements, and reporting to the authorizing entity, within a time frame to be agreed upon between each party and the authorizing entity, all requisite information related to orders for the licensed polymer, such as the quantity ordered, the date of order and the identity of the authorized purchaser;

- the licensed parties reporting to the authorizing entity the release of all shipments of ordered licensed polymer, such as the quantity shipped, the date and time of shipment and the receiving company's name and address within a period of time negotiated with the authorizing entity; and

- the licensed parties reporting to the authorizing entity any sublicenses granted to others to make and sell the licensed polymer.

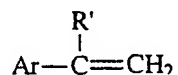
The license agreements discussed above between the authorizing entity, polymer technology holder and authorized replicator typically contains provisions for the use and/or disposal of offgrade or scrap licensed polymer, or used or scrap

information-carrying substrates produced from the licensed polymer, so as to prevent any type of use by parties other than authorized replicators in information-carrying substrate applications.

5 In the administration of and as part of the use of such licenses, royalties will typically be distributed in order to motivate all parties to support the process of the present invention.

The material used to produce the blank and information-carrying substrates useful in the present invention is typically a polymer material. In the case of optical media discs, the discs are preferably produced from an amorphous saturated
10 hydrocarbon thermoplastic. The term "saturated" refers to the amount of olefinic bonds within the chemical structure. As used herein, saturated refers to a polymer wherein less than 10 percent of the carbon-carbon bonds are olefinic or unsaturated in nature, generally less than 7.5 percent, typically less than 5 percent, advantageously less than 2 percent, more advantageously less than 1.5 percent,
15 preferably less than 1 percent, more preferably less than 0.5 percent and most preferably less than 0.2 percent being olefinic or unsaturated in nature. These types of polymers include, but are not limited to, hydrogenated aromatic polymers, cyclic-olefin-(co)polymers and hydrogenated ring opening metathesis polymers. These polymers can be distinguished from conventional polycarbonate by their lower density
20 and/or ability for increased light transmittance of the disc at wavelength of light below 635nm and/or decreased water absorption when compared to polycarbonate.

Hydrogenated aromatic polymers include any polymeric material containing a pendant aromatic functionality which has been subsequently hydrogenated. Pendant aromatic refers to a structure wherein the aromatic group is a substituent on the
25 polymer backbone and not embedded therein. Preferred aromatic groups are C₆₋₂₀ aryl groups, especially phenyl. These polymers may also contain (prior to hydrogenation) other olefinic groups in addition to the aromatic groups. In one embodiment, the polymer is derived from a monomer of the formula:



30 wherein R is hydrogen or alkyl, Ar is phenyl, halophenyl, alkylphenyl, alkylhalophenyl, naphthyl, pyridinyl, or anthracenyl, wherein any alkyl group contains 1 to 6 carbon atoms which may be mono or multisubstituted with functional groups such as halo, nitro, amino, cyano, carbonyl and carboxyl. More preferably Ar is phenyl or alkyl phenyl with phenyl being most preferred. Typical vinyl aromatic monomers which can

be used to produce such aromatic polymers include styrene, alpha-methylstyrene, all isomers of vinyl toluene, especially paravinyltoluene, all isomers of ethyl styrene, propyl styrene, vinyl biphenyl, vinyl naphthalene, and vinyl anthracene, and mixtures thereof. Homopolymers may have any stereostructure including syndiotactic, isotactic
5 or atactic; however, atactic polymers are preferred. In addition, hydrogenated copolymers derived from these aromatic monomers, including random, pseudo random, block and grafted copolymers, may be used in the process of the present invention. For example, hydrogenated copolymers of vinyl aromatic monomers and comonomers selected from: nitriles, acrylates, acids, ethylene, propylene, maleic
10 anhydride, maleimides, vinyl acetate, and vinyl chloride may also be used. Exemplary copolymers include hydrogenated styrene-acrylonitrile, styrene-alpha-methylstyrene and styrene-ethylene. Hydrogenated block copolymers of vinyl aromatic monomers and conjugated dienes such as butadiene, isoprene may also be used. Examples include styrene-butadiene, styrene-isoprene, styrene-butadiene-
15 styrene and styrene-isoprene-styrene copolymers. Further examples of block copolymers may be found in U.S. patents 4,845,173, 4,096,203, 4,200,718, 4,210,729, 4,205,016, 3,652,516, 3,734,973, 3,390,207, 3,231,635, and 3,030,346. Blends of such hydrogenated polymers with other polymers including impact modified, grafted rubber containing aromatic polymers may also be used. In one embodiment,
20 the hydrogenated aromatic polymer is polycyclohexylethylene (PCHE) prepared by hydrogenating atactic polystyrene as described in US-A-5,700,878.

The hydrogenated vinyl aromatic polymers which are especially preferred for use in the present invention include any aromatic polymer as described above, which has been hydrogenated to a level of at least 80 percent aromatic hydrogenation,
25 generally at least 85 percent, typically at least 90 percent, advantageously at least 95 percent, more advantageously at least 98 percent, preferably at least 98 percent, more preferably at least 99.5 percent, and most preferably at least 99.8 percent. Methods of hydrogenating aromatic polymers are well known in the art such as that described in U.S. 5,700,878 by Hahn and Hucul, wherein aromatic polymers are
30 hydrogenated by contacting the aromatic polymer with a hydrogenating agent in the presence of a silica supported metal hydrogenation catalyst having a narrow pore size distribution and large pores. The level of hydrogenation in hydrogenated vinyl aromatic polymers can be determined using UV-VIS spectrophotometry. If a diene copolymer is used, the level of hydrogenation in hydrogenated diene polymers is
35 determined using proton NMR.

The weight average molecular weight (Mw) of the aromatic polymers which are hydrogenated is typically from 10,000 to 3,000,000, more preferably from 50,000 to 1,000,000, and most preferably from 50,000 to 500,000. As referred to herein, Mw refers to the weight average molecular weight as determined by gel permeation chromatography (GPC).

Cyclic-olefin-polymers and copolymers are polymerized cycloolefin monomers exemplified by norbornene-type polymers such as are described in US-A-5,115,041, US-A-5,142,007, US-A-5,143,979. The cycloolefin moiety may be substituted or unsubstituted. Suitable cycloolefin monomers include substituted and unsubstituted norbornenes, dicyclopentadienes, dihydrodicyclopentadienes, trimers of cyclopentadiene, tetracyclododecenes, hexacycloheptadecenes, ethylidenyl norbornenes and vinylnorbornenes. Substituents on the cycloolefin monomers include hydrogen, alkyl alkenyl, and aryl groups of 1 to 20 carbon atoms and saturated and unsaturated cyclic groups of 3 to 12 carbon atoms which can be formed with one or more, preferably two, ring carbon atoms. The substituents on the cycloolefin monomers can be any which do not poison or deactivate the polymerization catalyst. Examples of preferred monomers include but are not limited to dicyclopentadiene, methyltetracyclo-dodecene, 2-norbornene, and other norbornene monomers such as 5-methyl-2-norbornene, 5,6-dimethyl-2-norbornene, 5-ethyl-2-norbornene, 5-ethylidenyl-2-norbornene, 5-butyl-2-norbornene, 5-hexyl-2-norbornene, 5-octyl-2-norbornene, 5-phenyl-2-norbornene, 5-dodecyl-2-norbornene, 5-isobutyl-2-norbornene, 5-octadecyl-2-norbornene, 5-isopropyl-2-norbornene, 5-p-toluyyl-2-norbornene, 5- α -naphthyl-2-norbornene, 5-cyclohexyl-2-norbornene, 5-isopropenyl-2-norbornene, 5-vinyl-2-norbornene, 5,5-dimethyl-2-norbornene, tricyclopentadiene (or cyclopentadiene trimer), tetracyclopentadiene (or cyclopentadiene tetramer), dihydrodicyclopentadiene (or cyclopentene-cyclopentadiene co-dimer), methyl-cyclopentadiene dimer, ethyl-cyclopentadiene dimer, tetracyclododecene 9-methyl-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, (or methyl-tetracyclododecene), 9-ethyl-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, (or ethyl-tetracyclododecene), 9-hexyl-tetracyclo-[6,2,1,1^{3,6}O^{2,7}]dodecene-4, 9-decyl-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, 9-decyl-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, 9,10-dimethyl-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, 9-methyl-10-ethyl-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, 9-cyclohexyl-tetracyclo [6,2,1,1^{3,6}O^{2,7}]dodecene-4, 9-chloro-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, 9-bromo-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, 9-fluoro-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, 9-

isobutyl-tetracyclo[6,2,1,1^{3,6}O^{2,7}]dodecene-4, and 9,10-dichlorotetracyclo[6,2,1,1^{3,6}O^{2,7}]-dodecene-4.

Polymers comprising two or more different types of monomeric units are also suitable. For example, copolymers of methyltetracyclododecane (MTD) and
5 methylnorbomene (MNB) are especially suitable. More preferably, the polymers comprise three or more different types of monomeric units, for example, terpolymers, including MTD, MNB and dicyclopentadiene (DCPD).

Ring opening metathesis polymers include polymers prepared by metathesis ring opening (co)polymerization of a norbornene or tetracyclododecene, such as
10 those described in JP-85/26,024 and US-A-5,053,471.

A polycarbonate polymer which has been modified to contain an anti-piracy characteristic may also be used. Such polycarbonates can be modified in a number of ways such that light transmittance of the disc at a specific wavelength of light can be used to identify the polymer. Modification includes the termination of the polymer
15 with an appropriate (identifiable or unique) phenolic compound, addition of a additive or marker, and copolymerization with a small quantity of a marker comonomer.

In another aspect of the present invention, the process of the present invention is further enhanced in high density optical media disc applications when the discs or hybrid discs are produced from a specified polymer which imparts at least one anti-piracy characteristic to the disc and the associated disc format is such that it requires
20 a new reader/player that possesses the capability of detecting the presence or absence of this anti-piracy characteristic in the disc and is in fact only capable of reading or playing discs bearing the anti-piracy characteristic.

Preferably, optical grade polymer technology, such as amorphous saturated hydrocarbon polymer technology, is used to produce high density (5 or more
25 Gigabyte) optical media discs, wherein the specified polymer selected enables the discs produced therefrom to possess one or more anti-piracy characteristics. Anti-piracy characteristics are measurable properties which can be detected within the optical media disc which is clearly discernible from prior art discs such as those made
30 from polycarbonate. Such anti-piracy characteristics include:

- the weight of the disc (amorphous saturated hydrocarbon polymers have lower densities than polycarbonate);
- the data transfer rate of the disc (discs produced from amorphous saturated hydrocarbon polymers have a faster data transfer rate while spinning the
35 disc at a given power input, than that of discs produced from polycarbonate);
- the light transmittance of a disc (discs produced from amorphous

saturated hydrocarbon polymers have a higher light transmittance at lower wave lengths of light (below 635 nm) than polycarbonate at disc thicknesses of greater than 100 microns);

- a polymer structure which allows for significantly reduced water absorption, thereby improving dimensional stability of the produced disc;
- the data access rate (discs produced from amorphous saturated hydrocarbon polymers have a faster data access rate while accelerating and decelerating, than that of discs produced from polycarbonate);
- the degree of water absorption (amorphous saturated hydrocarbon polymers have lower water absorption rates than polycarbonate, therefore they are more structurally stable and the need for barrier layers within a disc is eliminated and dimensional stability or flatness of the disc is enhanced); and
- the degree of wobble (wobble being the movement of a disc as it is spinning with respect to the horizontal plane). Due to low water absorption and high rigidity, discs produced from amorphous saturated hydrocarbon polymers have lower wobble than discs produced from polycarbonate, at higher spin rates as well as higher acceleration and deceleration rates.

High density optical media discs refer to optical media discs such as compact discs, and DVD, which have a density of at least 5 Gigabytes per disc, generally at least 7, typically at least 10, preferably at least 15, more preferably at least 20, even more preferably at least 25, and most preferably at least 30 Gigabytes per disc. These discs can be made from any polymer which has the ability to be molded, such that the appropriate density of grooves and pits can be replicated on the disc, while maintaining enough strength and other physical properties such that the disc is durable and rendered suitable for the intended optical media use.

The information processing device or reader/player which is compatible and interoperable with the class of anti-piracy substrates contains a piracy detection means or is configured to detect the anti-piracy characteristic of the substrate within an acceptable range of tolerance, to accommodate acceptable variations in the performance of the information processing device and in the manufacture of the substrate.

The information processing device may be configured to detect one or more anti-piracy characteristics. Below are several exemplary embodiments in which anti-piracy characteristics are defined and detected, which relates to an optical disc and associated reader/player. It is understood that similar characteristics may be applicable to other types of substrates that are in accordance with the present

invention (whether static, rotational or otherwise during operation with the information processing device), and other characteristics may be applicable to similar or other types of substrates.

5 In one embodiment, the reader/player comprises a means for determining the weight of the disc such that if the disc is too heavy, that is the weight of a standard polycarbonate disc, the player will not operate. The weight limitation is preset by the manufacturer of the reader/player. One example of a means can comprise a weighing mechanism which holds the disc and is in contact with an ON/OFF switch, wherein the mechanism will place the switch in the OFF position if the disc weighs
10 more than the preset value. This means will work well for determining PCHE discs or discs made from cyclic olefin polymers since the density of these polymers is much lower than that of standard polycarbonate.

In another embodiment, the reader/player comprises a means for determining the data transfer rate which is directly related to the spinning rate of the disc. This
15 rate would be preset by the manufacturer of the reader/player, so that if the required spin rate of the disc to achieve acceptable data transfer is not achieved at a preset power for the motor used to spin the disc, the reader/player would not read the disc. This means would also work well with cyclic olefin polymers and PCHE due to the lower density of the polymers and lower weight of the disc. In this connection, the
20 motor and controller of the reader/player is calibrated so that the data transfer rate and spin rate is keyed to the density and/or weight of the disc that is distinctively associated with PCHE or other selected polymer. The reader/player would operate with the substrate as characterized by its weight and/or density, in accordance with the process of the present invention.

25 In another embodiment, the reader/player comprises a means for determining the acceleration rate of the disc. This rate would be preset by the manufacturer of the reader/player, so that if the required acceleration rate of the disc is not achieved at a preset power input, the reader/player would not read the disc. This means would also work well with cyclic olefin polymers and PCHE due to the lower density of the
30 polymers and lower weight of the disc.

In another embodiment the player comprises a means for determining the light transmittance through the optical media disc at a specific wavelength, typically below 315 nm, preferably below 300nm. For example, the light transmittance for a substrate made of PCHE is preferably greater than substantially 40 percent per 0.6 mm
35 thickness of the substrate material, for an incident light having wavelength of substantially 243 to 297 nm. At such low wavelengths, the light transmittance of discs

made from polymers such as PCHE and cyclic olefin polymers would be significantly higher than that of discs made from standard polycarbonate. In this case, if the transmittance is not at the desired value, an OFF switch would be engaged.

5 In another embodiment the reader/player comprises a means for encoding and detecting a code on the optical media disc. If the code is not detected on the disc, the reader/player will not read the disc. This means is particularly useful on recordable discs, wherein the reader/player encodes the disc during recording. The reader/player encodes the serial number or other number unique to the machine performing the recording, as the identifying code onto the recordable disc. The
10 recorded disc is only playable on the recording reader/player which recorded it and detects its unique identifying code each time the disc is played.

In another embodiment, the reader/player comprises a means for detecting wobble. This can be detected by measuring the block rate error. If the block rate error is too high, the player will not play.

15 In one aspect, the means, as described in each of the preceding paragraphs referring to the reader/player, can comprise a microprocessor (or other type of circuit providing comparable capability, such as an application specific integrated circuit) and logic in the form of machine code, software, and/or firmware which is executed by the microprocessor (or other type of circuit).

20 Such players and methods of detection in optical media can be readily developed given the features and functions described in the present disclosure, based on disc players known in the art (for example, CD, LD and DVD) in combination with known technologies relating to the detection of physical and chemical characteristics applicable to the inventive substrate disclosed herein. For
25 example, references may be made to WO 97/24699; US-A-4,802,152; and Standard ECMA-267 "ECMA - Standardizing Information and Communication Systems" (December 1997).

The method of the present invention is further enhanced by the step of complying with an industry standard that has been established and substantially
30 adopted industry wide by content rights holders and information processing device providers for interoperability and compatibility of the class of substrates and information processing devices, as to reduce the opportunity for unauthorized duplication of information-carrying substrates.

The method of the present invention is further enhanced by controlling the
35 production of information processing devices that are operable with the class of

substrates. Controlling the production of information processing devices comprises at least one of the following steps:

- protecting a proprietary right for a structure of the information processing devices;
- 5 - protecting a proprietary right for a process for manufacturing the information processing devices;
- patenting a structure for the information processing devices;
- patenting a process for manufacturing the information processing devices;
- and/or
- 10 - controlling the production of the information processing devices by authorized information processing device producers.

The combination of polymer technology for high density formats, reader/player technology for piracy detection and the process of monitoring the production and delivery of optical media discs, will aid in the prevention of piracy or unauthorized
15 duplication of optical media discs.

This process can also be applied to lens technology, current DVD technology and super audio technology or hybrid CD/DVD technology as described in WO 98/38637, flash memory material, fiber optics, and computer chips.

In cases where the specified polymer can be used in applications other than the
20 manufacture of information-carrying substrates, the order to delivery process for both the polymer and parts manufactured can also be monitored in a similar fashion such that polymer cannot be obtained from other sources in order to make information-carrying substrates.

While the invention has been described in the context of substrates
25 manufactured at the time of information duplication (for example, the stamping of optical disc which involves manufacture of the disc and information placement or recording in a single process), the inventive concept of the present invention is also applicable to situations in which substrates are manufactured in a separate process (for example, recordable optical discs), and the manufactured substrates are then
30 used for carrying information later recorded thereon. That is, referring to the example depicted in Fig. 1, the block 3 may include separate substrate manufacturing and duplicating processes, or it may be replaced by separate blocks representing separate substrate manufacturing and duplicating processes.

CLAIMS:

1. A method for preventing unauthorized duplication of information to be distributed on an information-carrying substrate, comprising the steps of:
 - authorizing distribution of the information on a substrate of a type selected from a designated class of substrates, or authorizing the production of blank substrates of a type selected from a designated class of substrates;
 - distinguishing at least one designated anti-piracy characteristic that distinctively represents the type of substrate, which permits the information carried thereon to be accessed by an information processing device that is configured to detect such designated anti-piracy characteristics and that operates to access the information authorized to be distributed using said type of substrate when the designated anti-piracy characteristic has been detected, whereby any duplication of the information on other types of substrates outside said class of substrates would be recognized as not being an authorized duplication by said information processing device; and
 - controlling the availability of a selected substrate material to only 1) authorized information-carrying substrate producers for production of the information-carrying substrate and/or 2) authorized blank substrate producers for production of the blank substrates, thereby preventing unauthorized duplication of blank and/or information-carrying substrates by unauthorized substrate producers.
2. The method of claim 1 further comprising the step of including in the information of said information-carrying substrates, an indicator, representing that the authorized distribution of the information is through the use of said type of substrate having said designated anti-piracy characteristic.
3. The method of claim 2 wherein the indicator is detectable by the information processing device and which is relied upon by the information processing device to look for the designated anti-piracy characteristic upon detecting the indicator, indicating that the information is associated with said type of substrate, so that whether the information is an authorized duplication can be determined.
4. The method of claim 3 wherein the indicator is detectable and relied upon by the information processing device to apply a corresponding criteria to detect the designated anti-piracy characteristic associated with the type of substrate.
5. The method of claim 4 wherein the information of said information-carrying substrates is authorized to be distributed on substrates of two or more types selected from the designated class of substrates, and wherein the information includes different indicators corresponding to different designated anti-piracy characteristics of the different types of substrates.

6. The method of claim 5 wherein the different indicators are detectable and relied upon by the information processing device to apply different criteria to detect the different designated anti-piracy characteristics for the different types of substrates.

5 7. The method of claim 6 wherein the different information is distributed on different types of substrates, and wherein a different indicator is associated with a different type of substrate.

8. The method of claim 1 wherein the substrate is configured with at least one of the following sequences for playback:

- 10
- audio;
 - video;
 - text;
 - graphics; and/or
 - machine readable codes.

15 9. The method of claim 1 wherein the step of controlling the availability of selected substrate material only to 1) information-carrying substrate producers and/or 2) authorized blank substrate comprises at least one of the following steps:

- controlling the production of substrate materials by authorized substrate material producers;
- 20 - controlling the transfer of substrate materials to authorized information-carrying substrate producers;
- controlling the use of substrate materials by authorized information-carrying substrate producers;
- controlling the transfer of substrate materials to authorized blank substrate producers;
- 25 - controlling the use of substrate materials by authorized blank substrate producers;
- controlling the transfer of substrates by blank authorized substrate producers to authorized information-carrying substrate producers;
- 30 - controlling the use of blank substrates by authorized information-carrying substrate producers to produce authorized information-carrying substrates.

10. The method of claim 9 wherein one or more of the controlling steps is accomplished in part by at least one of the following:

- protecting a proprietary right for a composition of substrate material for
- 35 production of the substrate;

- protecting a proprietary right for a process for manufacturing the substrate material;

- patenting a composition for the substrate material; and

- patenting a process for manufacturing the substrate material.

5 11. The method of claim 9 further comprising the step of controlling the sales of information-carrying substrates by authorized distributors.

 12. The method of claim 1 wherein the controlling step comprises the step of:

10 monitoring at least one of the following in connection with production and delivery of blank and/or information-carrying substrates:

 (i) the amount of the substrate material produced by the authorized substrate material producers,

 (ii) the amount of substrate material transferred to authorized information-carrying substrate producers,

15 (iii) the number of the information-carrying substrates produced by the authorized information-carrying substrate producers from substrate material,

 (iv) the amount of the substrate material transferred to authorized blank substrate producers,

20 (v) the number of the blank substrates produced by the authorized blank substrate producers,

 (vi) the number of blank substrates transferred to the authorized information-carrying substrate producers,

 (vii) the number of information-carrying substrates produced by the authorized information-carrying substrate producers from blank substrates,

25 (viii) the number of information-carrying substrates transferred to the authorized distributors for distribution,

 (ix) the number of information-carrying substrates that are authorized by content rights owners to be produced by the authorized information-carrying substrate producers, and

30 (x) the number of blank substrates ordered by an authorized distributor to be produced by the authorized blank substrate producers.

 13. The method of claim 12 wherein the monitoring step comprises the step of designating an authorizing entity that monitors and correlates the number of substrates produced in (ix) or (x) to at least one of the number and amount quantities
35 in (i) to (viii), so as to determine whether substrate material and/or substrates have been made available to unauthorized substrate producers.

14. The method of claim 13 wherein the authorizing entity correlates the number of information-carrying substrates produced in (ix) to the number and volume quantities in (i), (ii), (iii), (vii) and (viii) and the number of blank substrates in (x) to the number and volume quantities in (iv) to (vi).

5 15. The method of claim 1 wherein the at least one anti-piracy characteristic designated for the type of substrate is represented by one of the following:

- density;
- mass;
- 10 - data transfer rate;
- optical characteristic;
- spectral characteristic;
- water absorption characteristic; or
- dimensional stability.

15 16. The method of claim 15 wherein the anti-piracy characteristic is designated such that it is detectable by the information processing device within a range of tolerance.

17. The method of claim 16 wherein the optical anti-piracy characteristic comprises a light transmittance characteristic of the substrate material.

20 18. The method of claim 17 wherein the substrate has a transmittance characteristic of greater than substantially 40 percent per 0.6 mm thickness of the substrate material for an incident light having wavelength of substantially 243 to 297 nm.

25 19. The method of claim 1 wherein the class of substrates comprises substrates that are configured for movement during operation with the information processing device.

20. The method of claim 19 wherein the movement is rotational movement, and wherein the at least one anti-piracy characteristic of the class of substrates is represented by one of the following:

- 30 - spin rate;
- moments of inertia;
- spin wobble; or
- acceleration and/or deceleration rate.

35 21. The method of claim 1 further comprising the step of complying with an industry standard that has been established and substantially adopted industry wide by content rights holders and information processing device providers for

interoperability and compatibility of the class of substrates and information processing devices, as to reduce the opportunity for unauthorized duplication of information-carrying substrates.

5 22. The method of claim 10 further comprising the step of complying with an industry standard that has been established and substantially adopted industry wide by content rights holders and information processing device providers for interoperability and compatibility of the class of substrates and information processing devices, as to reduce the opportunity for unauthorized duplication of information-carrying substrates.

10 23. The method of claim 1 further comprising the step of controlling the production of information processing devices that are operable with the class of substrates.

 24. The method of claim 23 wherein the step of controlling the production of information processing devices comprises at least one of the following steps:

- 15 - protecting a proprietary right for a structure of the information processing devices;
- protecting a proprietary right for a process for manufacturing the information processing devices;
- patenting a structure for the information processing devices;
- 20 - patenting a process for manufacturing the information processing devices; and/or
- controlling the production of the information processing devices by authorized information processing device producers.

25 25. The method of claim 1 further comprising the step of controlling the production and sales of production equipment for producing information-carrying substrates using the class of substrates.

 26. A process for producing a substrate of a type selected from a class of substrates which is designated for authorized distribution of information, the process comprising the step of using a substrate material, the availability of which is

30 controlled, to configure the substrates in a manner to exhibit a designated anti-piracy characteristic that distinctively represents the type of substrate, which permits access of the information by an information processing device that is configured to detect such characteristics and that operates to access the information authorized to be distributed using said type of substrate when the designated characteristic has been

35 detected, whereby any duplication of the information on other types of substrates

outside said class of substrates would be recognized as not being an authorized duplication by said information processing device.

27. A substrate of a type selected from a class of substrates which is designated for authorized distribution of information, comprising a body made of a substrate material, the availability of which is controlled, which contains the information and is configured in a manner to exhibit a designated anti-piracy characteristic that distinctively represents the type of substrate, which permits the information contained thereon to be accessed by an information processing device that is configured to detect such designated anti-piracy characteristic and that operates to access the information authorized to be distributed using said type of substrate when the designated anti-piracy characteristic has been detected, whereby any duplication of the information on other types of substrates outside said class of substrates would be recognized as not being an authorized duplication by said information processing device.

28. A method of preventing unauthorized duplication of blank and/or information-carrying substrates comprising the step of monitoring at least one of the following in connection with production and delivery of blank and/or information-carrying substrates:

(i) the amount of the substrate material produced by authorized substrate material producers, wherein the substrate material is for making substrates of a type selected from a class of designated substrates, which exhibits at least one anti-piracy characteristic that distinctively represents the type of substrate and that permits the information either prerecorded in the information-carrying substrates or later recorded on the blank substrates, to be accessed by an information processing device that is configured to detect such designated anti-piracy characteristics and that operates to access the information authorized to be distributed using said designated class of substrates when the designated anti-piracy characteristic has been detected, whereby any duplication of the information on other types of substrates outside said class of substrates would be recognized as not being an authorized duplication by said information processing device;

(ii) the amount of the substrate material transferred to authorized information-carrying substrate producers;

(iii) the number of the information-carrying substrates produced by authorized information-carrying substrate producers from substrate material;

(iv) the amount of the substrate material transferred to authorized blank substrate producers;

- (v) the number of blank substrates produced by authorized blank substrate producers;
 - (vi) the number of blank substrates transferred to the authorized information-carrying substrate producers;
 - 5 (vii) the number of information-carrying substrates produced by authorized information-carrying substrate producers from blank substrates;
 - (viii) the number of information-carrying substrates transferred to authorized distributors;
 - (ix) the number of information-carrying substrates that are authorized by
10 content rights holder to be produced by authorized information-carrying substrate producers; and/or
 - (x) the number of blank substrates ordered by an authorized distributor to be produced by the authorized blank substrate producers.
29. A monitoring system for monitoring and correlating the amount of
15 substrate material and the number of blank and/or information-carrying substrates produced so as to determine whether substrate material and/or substrates have been made available to unauthorized substrate producers, comprising:
- means for monitoring at least one of the following:
- (i) the amount of the substrate material produced by authorized substrate
20 material producers, wherein the substrate material is for producing substrates of the type selected from a class of substrates which exhibits at least one anti-piracy characteristic that distinctively represents the type of substrates, which allows the information either prerecorded in the information-carrying substrates or later
25 recorded on the blank substrates, to be accessed by an information processing device that is configured to be operable with said type of substrates when said anti-piracy characteristic has been detected;
 - (ii) the amount of the substrate material transferred to authorized information-carrying substrate producers;
 - (iii) the number of information-carrying substrates produced by authorized
30 information-carrying substrate producers from substrate material;
 - (iv) the amount of the substrate material transferred to authorized blank substrate producers;
 - (v) the number of the blank substrates produced by authorized blank substrate producers;
 - 35 (vi) the number of blank substrates transferred to the authorized information-carrying substrate producers;

(vii) the number of information-carrying substrates produced by authorized information-carrying substrate producers from blank substrates;

(viii) the number of information-carrying substrates transferred to authorized distributors for distribution;

5 (ix) the number of information-carrying substrates that are authorized by information owners to be produced by authorized information-carrying substrate producers, and/or

(x) the number of blank substrates ordered by an authorized distributor to be produced by the authorized blank substrate producers.

10 30. A substrate material for a substrate of a type selected from a class of substrates which is designated for authorized distribution of information, comprising a composition of matter suitable for manufacturing substrates that are configured in a manner to exhibit an anti-piracy characteristic that distinctively represents the class of substrates, which permits access of the information by an information processing
15 device that is configured to detect such characteristics and that operates to access the information authorized to be distributed using said designated class of substrates when the designated anti-piracy characteristic has been detected, whereby any duplication of the information on other types of substrates outside of said class would be recognized as not being an authorized duplication by said information processing
20 device.

31. A machine readable substrate suitable for carrying machine readable information produced by a process comprising the steps of:

-providing a material selected from a designated class of material;

25 -forming a substrate from the material so that there is at least one anti-piracy characteristic of the substrate detectable by at least one of an electrical, optical or mechanical mechanism during machine reading of the substrate; and

-administering the step of forming of the substrate so as to produce data concerning a relationship between an amount of designated material at the beginning of the step of forming and the number of substrates at the end of the step of forming.

30 32. The substrate of claim 31 wherein the step of administering includes the step of producing data to explain discrepancies between the amount of material at the beginning of the step of forming and the number of substrates at the end of the step of forming.

35 33. The substrate of claim 31 wherein the step of forming includes the step of duplicating information onto at least one substrate formed during the step of forming; and the step of administering includes administering the duplication of

information onto each substrate produced in the step of forming so that there is data concerning a relationship between an amount of material at the beginning of the step of forming and the number of information carrying substrates at the end of the step of forming.

5 34. The substrate of claim 31 wherein the material is subject to proprietary right protection.

 35. The substrate of claim 31 wherein the step of forming includes the step of duplicating copyrighted information onto at least one substrate formed during the step of forming; and the step of administering includes administering the duplicating of
10 the copyrighted information onto substrates produced in the step of forming so that there is data concerning a relationship between an amount of material at the beginning of the step of forming and the number of information-carrying substrates at the end of the step of forming.

 36. The substrate of claim 31 wherein the step of administering includes
15 the step of producing data to explain discrepancies between the amount of material at the beginning of the step of forming and the number of substrates at the end of the step of forming.

 37. The substrate of claim 31 wherein the step of administering includes reporting the data to a content rights holder.

20 38. An anti-piracy process comprising the steps of:

 -providing a substrate made from a material selected from a designated class, so that at least one distinctive identifying characteristic of the substrate is detectable by at least one of an electrical, optical or mechanical mechanism during machine reading of the substrate; and

25 -administering the step of forming of the substrate so as to produce data concerning a relationship between an amount of material at the beginning of the step of forming and the number of substrates at the end of the step of forming.

 39. The process of claim 38 further comprising the step of detecting whether or not a respective suspect substrate has the distinctive identifying
30 characteristic of a substrate formed in accordance with the steps of forming and administering.

 40. The process of claim 39 further comprising:

 -detecting whether or not a respective suspect substrate has the distinctive identifying characteristic of a substrate formed in accordance with the steps
35 of forming and administering; and

 -identifying the suspect substrate as an unauthorized substrate if the

distinctive identifying characteristic is not detected.

41. A process for managing information in preventing the unauthorized duplication of information-carrying substrates and electronically monitoring the "order to delivery" steps of a supply chain utilizing a computer or computer network, wherein the steps comprise:

- ordering of information-carrying substrates,
- ordering of polymer to produced the said substrates,
- producing and delivering (shipping and receiving) said polymer,
- producing said substrates, and
- delivering (shipping and receiving) said substrates;

comprising:

- storing at least one data value in the memory of a computer which corresponds to the number of said substrates ordered,

- storing at least one data value in the memory of a computer which

corresponds to the amount of specified polymer ordered to produce said substrates,

- storing at least one data value in the memory of a computer which corresponds to the amount of said polymer produced,

- storing at least one data value in the memory of a computer which corresponds to the amount of said polymer shipped,

- storing at least one data value in the memory of a computer which corresponds to the amount of said polymer received,

- storing at least one data value in the memory of a computer which corresponds to the number of said substrates produced, and

- storing at least one data value in the memory of a computer which corresponds to the number of said substrates shipped,

- storing at least one data value in the memory of a computer which corresponds to the number of said substrates received, and

- electronically analyzing the data values related to the number of substrates ordered, the number of substrates produced, the numbers of substrates shipped and the number of substrates received; and the amount of polymer ordered, the amount of polymer produced, the amount of polymer shipped, and the amount of polymer received to identify any discrepancies.

42. The process of Claim 41 wherein the information-carrying substrates are optical media discs.

43. The process of Claim 41 wherein the data values are electronically recorded and verified by an authorizing entity.

44. The process of Claim 42 wherein the information-carrying substrate possesses one or more anti-piracy characteristics, said characteristic being detectable on an optical media disc player/reader having a piracy detection means.

45. The process of Claim 44 wherein the anti-piracy characteristic is selected from the group consisting of low disc weight, rapid disc data transfer rate, acceleration rate, high light transmittance at specific wavelengths, low water absorption, rapid data access rate, and low disc wobble.

46. The process of Claim 41 wherein the polymer is a hydrogenated vinyl aromatic polymer.

47. The process of Claim 46, wherein the polymer is a hydrogenated copolymer produced from a vinyl aromatic monomer and a conjugated diene monomer.

48. The process of Claim 41 wherein the data value(s) corresponding to the amount of specified polymer ordered is received by an authorizing entity from an authorized polymer producer, which is licensed by the authorizing entity to produce said polymer and is obligated to report to the authorizing entity the amount of polymer produced and shipped under such license; and wherein the data value(s) corresponding to the amount of polymer received is received from the authorizing entity from an authorized replicator, which is licensed by the authorizing entity to use said polymer in the production of substrates and is obligated to report to the authorizing entity the amount of polymer received under such license; and wherein the data value(s) corresponding to the number of information-carrying substrates produced and shipped is received by the authorizing entity from the authorized replicator; and wherein the data value(s) corresponding to the number of substrates received is received by the authorizing entity from an authorized distributor which is licensed by the authorizing entity to sell the information-carrying substrates produced and is obligated to report to the authorizing entity the number of information-carrying substrates received under such license.

49. A process for electronically monitoring the production and delivery of optical media discs, useful in preventing unauthorized duplication comprising:

- a) receiving an order notification for pre-recorded or blank recordable optical media discs, wherein the notification identifies an authorized optical media disc replicator who will produce the discs and entering and storing the information associated with the order in a computer;
- b) electronically analyzing the information entered associated with the order to convert the number of discs ordered to the amount of specified polymer needed to

produce the number of discs ordered,

c) ordering the amount of said polymer needed from a authorized polymer producer(s), wherein the authorized polymer producer(s) has been specified by the authorized replicator and entering and storing the information associated with ordering the polymer in a computer,

d) notifying the authorized replicator of the amount of polymer ordered,

e) receiving notification from the authorized polymer producer(s) of the amount of polymer produced and the amount of polymer shipped to the authorized replicator and entering and storing the information associated with the amount of polymer produced and the amount of polymer shipped to the authorized replicator in a computer,

f) receiving notification from the authorized replicator of the amount of polymer received from the authorized polymer producer(s) and entering and storing the information associated with the amount of polymer received from the authorized polymer producer(s) in a computer,

g) electronically analyzing and comparing the amounts reported by the authorized replicator and the authorized polymer producer(s) to identify any significant discrepancies in the amount of polymer ordered versus the amount of polymer produced, the amount of polymer shipped and/or the amount of polymer received,

h) receiving notification from the authorized replicator of the number of discs produced and shipped or delivered to an authorized distribution center and entering and storing the information associated with the number of discs produced and shipped or delivered to an authorized distribution center in a computer, and

i) receiving notification from the authorized distribution center of the number of discs delivered or received and entering and storing the information associated with the number of discs delivered or received by the authorized distribution center in a computer, and

j) electronically analyzing and comparing the number of discs reported to be produced by the authorized replicator, the number of discs reported as received by the authorized distribution center, and the number of discs originally ordered, and identifying any discrepancies,

k) comparing the amount of polymer produced by the authorized polymer producer, the amount of polymer shipped by the authorized polymer producer, and the amount of polymer received by the authorized replicator, and identifying any significant discrepancies.

50. A process for preventing the unauthorized duplication of information-

carrying substrates comprising the steps of :

I) establishing an authorizing entity to monitor the "order to delivery" steps of a supply chain in the production and delivery of information-carrying substrates;

5 II) establishing or defining one or more anti-piracy characteristics imparted on the information-carrying substrate, which enables the information contained within the information-carrying substrate to be accessed only through the use of a information processing device having a piracy detection means; and

III) monitoring the "order to delivery" steps of a supply chain in the production and delivery of the information-carrying substrates.

10 51. The process of Claim 50 wherein step III) is accomplished by electronically monitoring the "order to delivery" steps of a supply chain utilizing a computer or computer network, wherein the steps comprise:

--ordering of information-carrying substrates,

--ordering of polymer to produced the said substrates,

15 --producing and delivering (shipping and receiving) said polymer,

--producing said substrates, and

--delivering (shipping and receiving) said substrates;

wherein the process comprises:

20 --storing at least one data value in the memory of a computer which corresponds to the number of said substrates ordered,

-- storing at least one data value in the memory of a computer which corresponds to the amount of specified polymer ordered to produce said substrates,

-- storing at least one data value in the memory of a computer which corresponds to the amount of said polymer produced,

25 -- storing at least one data value in the memory of a computer which corresponds to the amount of said polymer shipped,

-- storing at least one data value in the memory of a computer which corresponds to the amount of said polymer received,

30 -- storing at least one data value in the memory of a computer which corresponds to the number of said substrates produced, and

-- storing at least one data value in the memory of a computer which corresponds to the number of said substrates shipped,

-- storing at least one data value in the memory of a computer which corresponds to the number of said substrates received, and

35 --electronically analyzing the data values related to the number of substrates ordered, the number of substrates produced, the numbers of substrates shipped and

the number of substrates received; and the amount of polymer ordered, the amount of polymer produced, the amount of polymer shipped and the amount of polymer received to identify any discrepancies.

52. The process of Claim 51 wherein the information-carrying substrates
5 are optical media discs.

53. The process of Claim 52 wherein the process is monitored by an authorizing entity.

54. The process of Claim 52 wherein the optical media disc contains one or more anti-piracy characteristic, said characteristic being detectable on an optical
10 media disc player/reader having a piracy detection means.

55. The process of Claim 54 wherein the anti-piracy characteristic is selected from the group consisting of low disc weight, rapid disc data transfer rate, acceleration rate, high light transmittance at specific wavelengths, low water absorption, rapid data access rate, and low disc wobble.

15 56. A general purpose computer or computer network useful for managing information in preventing the unauthorized duplication of information-carrying substrates and electronically monitoring the "order to delivery" steps of a supply chain, wherein the steps comprise:

- ordering of information-carrying substrates,
- 20 --ordering of polymer to produced the said substrates,
- producing and delivering (shipping and receiving) said polymer,
- producing said substrates, and
- delivering (shipping and receiving) said substrates;

wherein the computer or computer network comprises:

- 25 --a means for storing at least one data value in the memory of a computer which corresponds to the number of said substrates ordered,
- a means for storing at least one data value in the memory of a computer which corresponds to the amount of specified polymer ordered to produce said substrates,
- 30 -- a means for storing at least one data value in the memory of a computer which corresponds to the amount of said polymer produced,
- a means for storing at least one data value in the memory of a computer which corresponds to the amount of said polymer shipped,
- a means for storing at least one data value in the memory of a computer
35 which corresponds to the amount of said polymer received,
- a means for storing at least one data value in the memory of a computer

which corresponds to the number of said substrates produced, and

-- a means for storing at least one data value in the memory of a computer which corresponds to the number of said substrates shipped,

-- a means for storing at least one data value in the memory of a computer

5 which corresponds to the number of said substrates received, and

--a means for electronically analyzing the data values related to the number of substrates ordered, the number of substrates produced, the numbers of substrates shipped and the number of substrates received; and the amount of polymer ordered, the amount of polymer produced, the amount of polymer shipped, and the amount of
10 polymer received to identify any discrepancies.

57. The computer or computer network of Claim 56 wherein the information-carrying substrates are optical media discs.

58. The computer or computer network of Claim 56 which is monitored by an authorizing entity.

15 59. The computer or computer network of Claim 57 wherein the optical media disc possesses one or more anti-piracy characteristics, said characteristic being detectable on an optical media disc player/reader having a piracy detection means.

20 60. The computer or computer network of Claim 59 wherein the anti-piracy characteristic is selected from the group consisting of low disc weight, rapid disc data transfer rate, acceleration rate, high light transmittance at specific wavelengths, low water absorption, rapid data access rate, and low disc wobble.

25 61. A computer or computer network for electronically monitoring the production and delivery of optical media discs, useful in preventing unauthorized duplication comprising:

a) means for entering and storing information associated with an order notification for pre-recorded or blank recordable optical media discs, wherein the notification identifies an authorized optical media disc replicator who will produce the discs and

30 b) means for electronically analyzing the information associated with the order notification entered to determine the amount of specified polymer needed to produce the number of discs ordered,

c) means for entering and storing information associated with ordering the polymer from a authorized polymer producer(s), wherein the authorized polymer
35 producer(s) has been specified by the authorized replicator and

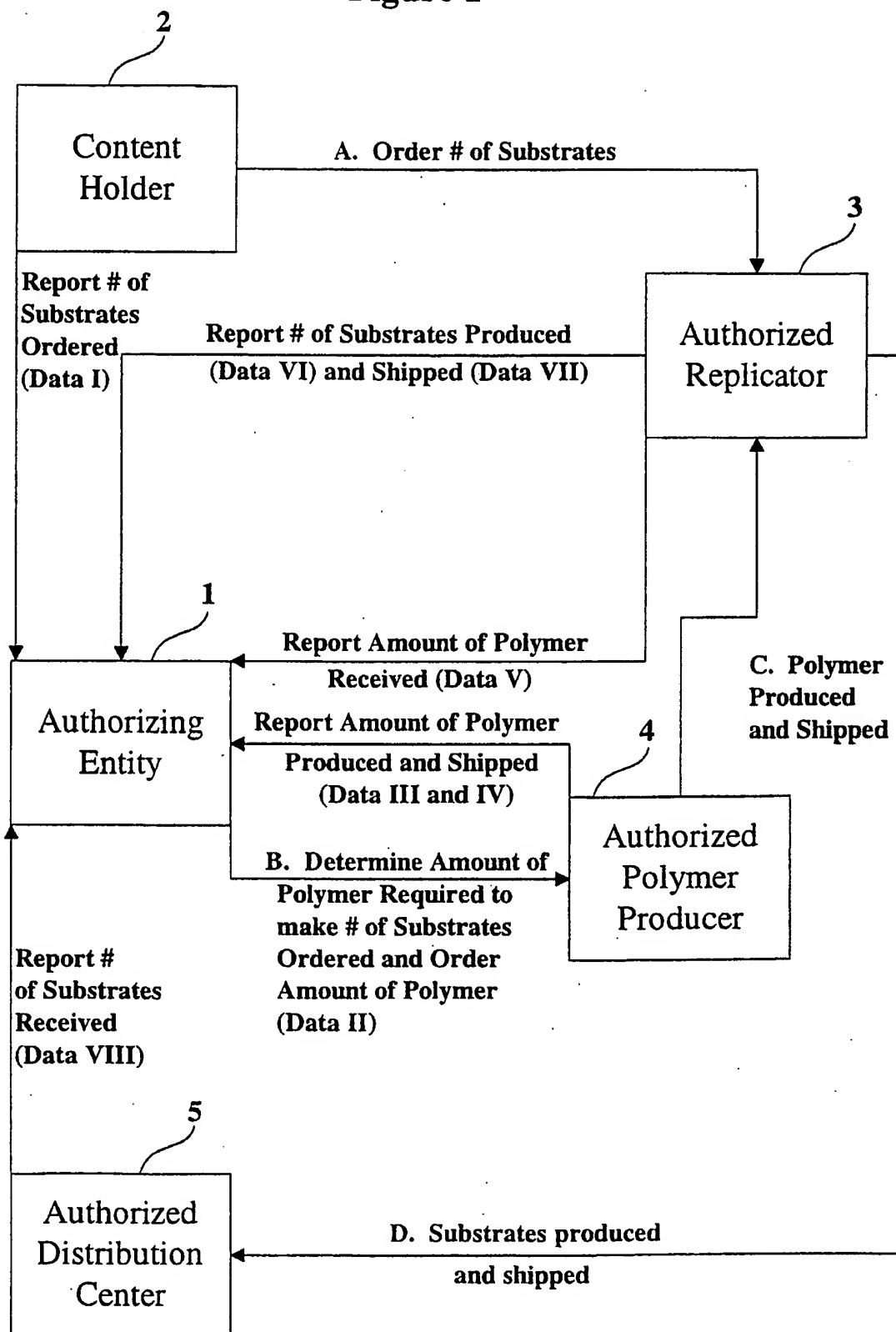
d) means for notifying the authorized replicator of the amount of polymer

ordered,

- e) means for receiving notification from the authorized polymer producer(s) of the amount of polymer produced and shipped to the authorized replicator and means for entering and storing the information associated with the amount of polymer
5 produced and shipped to the authorized replicator,
- f) means for receiving notification from the authorized replicator of the amount of polymer received from the authorized polymer producer(s) and means for entering and storing the information associated with the amount of polymer received from the authorized polymer producer(s) in a computer,
- 10 g) means for electronically analyzing and comparing the amounts reported by the authorized replicator and the authorized polymer producer(s) to identify any significant discrepancies in the amount of polymer ordered versus the amount of polymer produced, the amount of polymer shipped and/or the amount of polymer received,
- 15 h) means for receiving notification from the authorized replicator of the number of discs produced and shipped or delivered to an authorized distribution center and means for entering and storing the information associated with the number of discs produced and shipped or delivered to an authorized distribution center in a computer, and
- 20 i) means for receiving notification from the authorized distribution center of the number of discs delivered or received and means for entering and storing the information associated with the number of discs delivered or received by the authorized distribution center in a computer, and
- 25 j) means for electronically analyzing and comparing the number of discs reported to be produced by the authorized replicator, the number of discs reported as received by the authorized distribution center, and the number of discs originally ordered, and means for identifying any discrepancies.

1 / 1

Figure 1



INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 99/19081

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G11B7/24 G11B19/00 G11B23/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 09, 30 September 1996 (1996-09-30) & JP 08 138268 A (VICTOR CO OF JAPAN LTD), 31 May 1996 (1996-05-31)	26, 27, 30
A	abstract	1-25, 28, 29, 31-61
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 08, 30 August 1996 (1996-08-30) & JP 08 096508 A (VICTOR CO OF JAPAN LTD), 12 April 1996 (1996-04-12)	26, 27, 30
A	abstract	1-25, 28, 29, 31-61

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

18 November 1999

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29/11/1999

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/19081

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 08138268 A	31-05-1996	NONE	
JP 08096508 A	12-04-1996	NONE	